4.3 Cropping Management

Rotating crops can help maintain soil fertility and reduce the need for chemical fertilizers and pesticides. Most corn and soybeans are grown in rotation with each other or other row crops. The most predominant wheat rotation is wheat-fallow-wheat, while monoculture is the most common practice in cotton. The primary factor determining a farmer's choice of cropping pattern is the rate of return; other contributing factors include agroclimatic conditions, farm programs, conservation programs, and environmental regulations. Crop rotations, generally. will prevail over monoculture only if more profitable.

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Rotating crops to help maintain soil fertility, reduce soil erosion, and control insects and diseases (by disrupting the life cycle of insect pests, weeds, and plant pathogens) was much more common before the mid-1950s, when farmers increased their reliance on insecticides, herbicides, and fungicides, and commercial fertilizers as a means of sustaining or increasing yields. More recently, public concerns about the hazards of these chemicals in the food chain and in ground and surface water have prompted policy makers, universities, and other private sector decision makers to examine ways to reduce the use of these chemicals in agricultural production. Consequently, farmers are increasingly considering production alternatives, including crop rotation, to reduce adverse environmental consequences.

Farmers choose between crop rotation (planting different crops successively in the same field) and monoculture (or continuous cropping) based on agro-climatic and economic factors. This choice, in turn, frequently affects the use of fertilizers and pesticides. The Cropping Practices Survey, which collects a 3-year cropping history, indicates various cropping patterns and how they affect input use in the production of corn, soybeans, cotton, and wheat—the four major commercial crops (see box, "Cropping Pattern Definitions").

Environmental Benefits of Crop Rotations

The potential benefits of crop rotation include improved fertility by including nitrogen fixing legumes in crop rotation; reduced incidence of plant diseases, insects, and weeds; reduced loss of soil, nutrients, and moisture; increased water-holding capacity of the soil through increased organic matter; and reduced water pollution often associated with runoff and leaching. However, short-term benefits accruing to the farmer may not be sufficient to prevent a reduction in earnings from substituting one crop with another, unless the new crop can by used by onfarm livestock.

Crop rotations improve soil conditions so that in most cases yields of grain crops will increase beyond those achieved with continuous cropping (Heichel, 1987; Power, 1987). Corn following wheat, which is not a

Cropping Pattern Definitions

The following definitions were applied to 3-year crop sequence data reported in the Cropping Practices Survey to represent a cropping pattern for each sample field. The data were limited to the current year's crop plus the crops planted the previous 2 years on the sample field.

Monoculture or continuous same crop—A crop sequence where the same crop is planted for 3 consecutive years. Small grains (wheat, oats, barley, flax, rye, etc.) or other close-grown crops may be planted in the fall as a cover crop. The rotation excludes soybeans double-cropped with winter wheat.

Continuous row crops—A crop sequence, excluding continuous same crop, where only row crops (corn, sorghum, soybeans, cotton, peanuts, vegetables, etc.) are planted for 3 consecutive years. Small grains or close-grown crops may be planted in the fall as a cover crop.

Mix of row crops and small grains—A crop sequence where some combination of row crops and small grains are planted over the 3-year period. The rotation excludes soybeans double-cropped with winter wheat.

Hay, pasture, or other use in rotation—A crop sequence that includes hay, pasture, or other use in 1or more previous years. The rotation excludes any of the above rotations and any area that was idle or fallow in one of the previous years.

Idle or fallow in rotation—A crop sequence that includes idle, diverted, or fallowed land in 1 or more of the previous years.

Double-cropped soybeans—A crop sequence, limited to soybean acreage, where winter wheat was planted the previous fall.

legume, produces a greater yield than continuous corn when the same amount of fertilizer is applied (Power, 1987). Yields following legumes are often 10 to 20 percent higher than continuous grain regardless of the amount of fertilizer applied (National Research Council, 1989).

Crop rotations can also control insects, diseases, and weeds, particularly those pests that attack plant roots. Crop rotations aid in insect management by replacing a susceptible crop with a non-host crop. Rotating corn with soybeans may reduce soil population of corn rootworm larvae and thereby reduce the need for insecticide treatment. In the southern United States, when peanuts are rotated with cotton and corn, the nematode population drops. If cotton is rotated with corn or grown continuously, then the sting nematode can build up to devastating levels in a few years.

Crop rotations can also help control soil erosion. Closely sown field grain crops such as wheat, barley, and oats, as well as most hay and forage crops, provide additional vegetative cover to reduce soil erosion. In addition, these crops also compete with broadleaf weeds and may help control the weed infestation in subsequent crops since they are usually harvested before weeds reach maturity and produce seed.

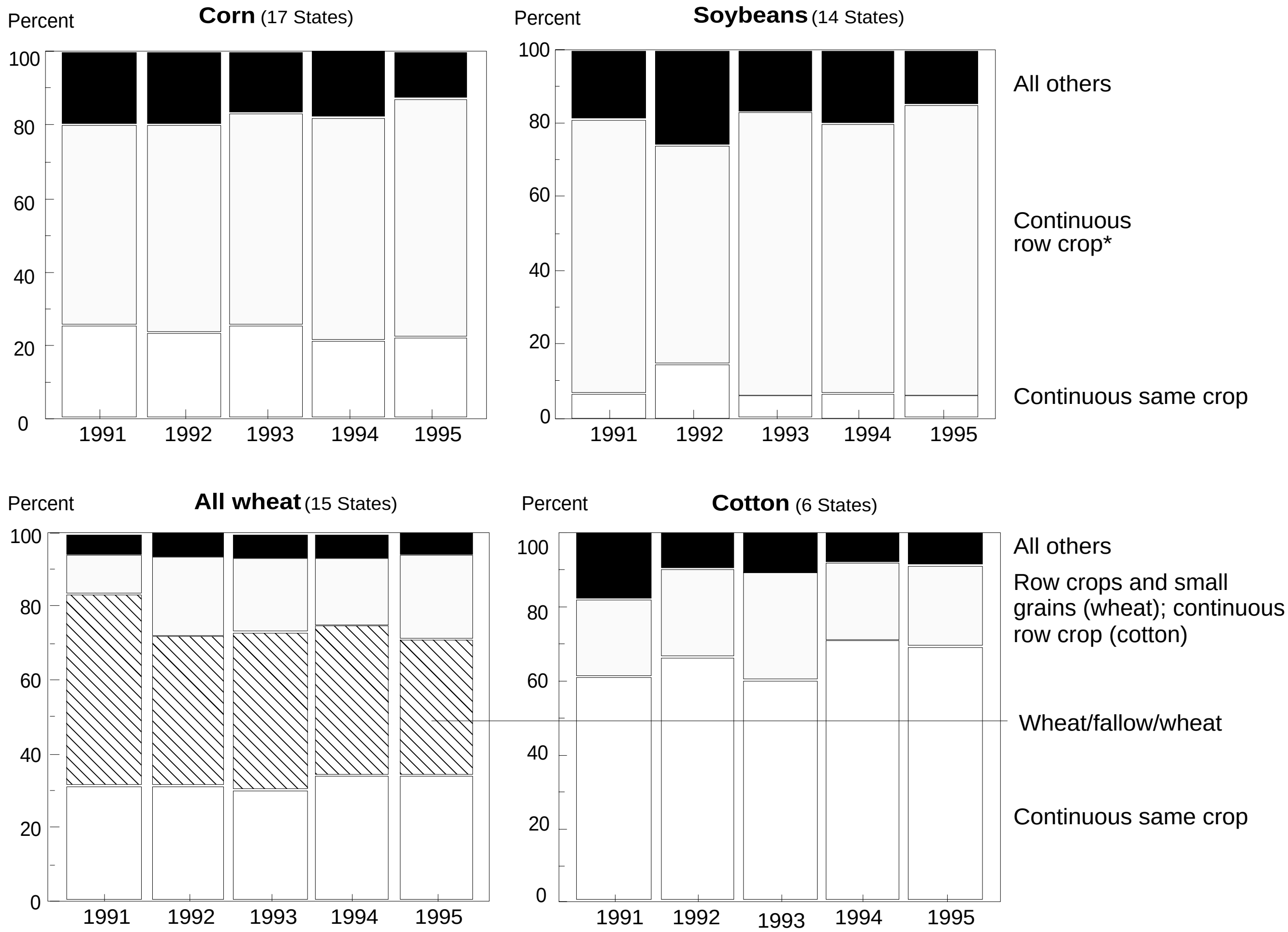
Finally, all rotations promote diversification and can provide an economic buffer against price fluctuations for crops and production inputs. Diversification also helps reduce the vagaries of weather and disease and pest infestations.

Cropping Patterns on Land Producing Major Crops

Corn. Cropping Practices Survey data (see appendix for a description of the survey) indicate that for most areas of the United States, farmers varied the crops planted from year to year. In the 17 major corn growing States, about 63 percent of the corn acreage in 1995 was in rotation with soybeans or other row crops (table 4.3.1, fig. 4.3.1). Twenty-one percent was in continuous corn. Only 9 percent of corn acreage was in rotation with small grains, hay, or pasture and the remaining 7 percent was idle for at least 1 of the 2 preceding years. Over 1991-95, corn monoculturing appears to have declined slightly, while continuous row cropping has slowly but steadily increased (fig. 4.3.1).

Soybeans. Nearly three-fourths of soybean acreage in 14 major producing States in 1995 was reported in rotation with corn or other row crops (fig. 4.3.1, table 4.3.1). Continuous soybeans (monoculture) occurred on only 10 percent of the acreage. Farmers in the

Figure 4.3.1--Trends in major cropping patterns, 1991-95



* Corn mostly in rotation with soybeans.
Source: USDA, ERS, Cropping Practices Survey data.
For States included, see "Cropping Practices Survey" in the appendix.

Northern States mostly rotated soybeans with corn, whereas Southern farmers tended to plant continuous soybeans. Over 1991-95, the rotation of soybeans with other row crops increased, while the proportion in continuous soybeans remained low (fig. 4.3.1).

Cotton. In 1995, 68 percent of the cotton acreage in the 6 major cotton producing States followed a continuous cotton pattern (fig. 4.3.1, table 4.3.1). Continuous row crops accounted for another 21 percent. Over 1991-95 period, cotton monoculturing increased.

Wheat. The two predominant cropping patterns in the major wheat growing States were continuous wheat (34 percent of total wheat acreage) and wheat-fallow-wheat (37 percent) (fig. 4.3.1, table 4.3.1). Much of the wheat in the United States is grown in the Great Plains, where moisture is limited. Farmers in these areas prefer the moisture-conserving wheat-fallow-wheat rotation. However, wheat with row crops is mostly grown in the more humid regions such as Illinois, Missouri, Ohio, and Minnesota. The rotation of wheat with row crops and other small grains (23 percent in 1995) may be increasing, while a wheat-fallow-wheat pattern may be declining (fig. 4.3.1). Also, the share of wheat acreage in continuous wheat was up slightly in 1994 and 1995 compared with 1991-93.

Rotations and Chemical Use

Herbicide use. Most acres in corn, cotton, and soybeans received one or more herbicide treatments, regardless of the cropping pattern (table 4.3.1). Some differences existed among patterns in the annual pounds of active ingredient applied per treated acres but these have not been consistent from year to year

Table 4.3.1—Cropping patterns and associated chemical use in major producing States, 1995[1]

Crop/Item	3-year crop sequence[2]: Continuous: Same crop	Continuous: Row crops	Continuous: Small grains	Combination row crops and small grains	Idle or fallow	Hay, pasture or other crops	Double-cropped w/wheat or soybeans	Total
Corn: (17 States)								
Planted acres (1,000 ac.)	13,581	40,050	n/a	1,770	4,480	4,224	n/a	64,105
Planted acres treated with:				*Percent of planted acres*				
Nitrogen	96.7	98.2	n/a	90.2	98.1	95.2	n/a	97.4
Phosphate	76.6	82.3	n/a	65.5	77.9	86.6	n/a	80.6
Potash	55.3	75.4	n/a	36.9	61.6	82.6	n/a	69.6
Herbicides	95.8	98.2	n/a	93.7	94.2	93.0	n/a	97.0
Insecticides	58.7	18.9	n/a	4.2	24.7	22.4	n/a	27.5
Average application rates for:				*Pounds a.i. per treated acre*				
Nitrogen	138	136	n/a	85	120	82	n/a	130
Phosphate	43	63	n/a	37	52	44	n/a	56
Potash	63	85	n/a	43	74	60	n/a	78
Herbicides	2.54	2.81	n/a	2.14	2.65	2.50	n/a	2.71
Insecticides	0.80	0.67	n/a	1.03	0.75	0.97	n/a	0.75
Soybeans: (14 States)								
Planted acres (1,000 ac.)	5,088	37,932	n/a	2,293	2,311	763	3,454	51,840
Planted acres treated with:				*Percent of planted acres*				
Nitrogen	18.0	15.3	n/a	23.6	10.7	19.3	29.9	17.0
Phosphate	27.4	19.1	n/a	36.5	21.4	33.8	31.5	22.0
Potash	30.2	23.0	n/a	35.4	23.7	33.8	36.5	25.3
Herbicides	93.7	99.0	n/a	91.4	95.1	90.2	92.9	97.5
Insecticides	7.8	1.0	n/a	1.3	0.4	id	4.1	1.8
Average application rates for:				*Pounds a.i. per treated acre*				
Nitrogen	32	27	n/a	26	15	35	42	29
Phosphate	44	57	n/a	49	38	56	56	54
Potash	71	91	n/a	55	73	85	79	85
Herbicides	1.28	1.07	n/a	1.42	1.33	0.66	1.22	1.12
Insecticides	0.56	0.39	n/a	0.64	0.58	id	0.57	0.49
Cotton: (6 States)								
Planted acres (1,000 ac.)	7,938	2,453	n/a	205	781	274	n/a	11,650
Planted acres treated with:				*Percent of planted acres*				
Nitrogen	85.3	93.0	n/a	95.1	79.6	87.6	n/a	86.8
Phosphate	52.6	72.5	n/a	69.6	40.4	55.3	n/a	56.3
Potash	44.0	35.1	n/a	44.6	20.6	34.0	n/a	40.3
Herbicides	98.5	95.8	n/a	83.4	95.7	100.0	n/a	97.5
Insecticides	73.2	81.7	n/a	84.4	81.0	92.3	n/a	76.2
Average application rates for:				*Pounds a.i. per treated acre*				
Nitrogen	93	91	n/a	137	123	148	n/a	96
Phosphate	40	47	n/a	46	48	59	n/a	43
Potash	53	47	n/a	57	31	40	n/a	51
Herbicides	2.16	1.78	n/a	2.17	1.38	2.16	n/a	2.03
Insecticides	2.36	2.28	n/a	3.18	2.27	2.66	n/a	2.36
All wheat: (15 States)								
Planted acres (1,000 ac.)	17,982	n/a	1,949	11,934	19,423	1,262	414	52,965
Planted acres treated with:				*Percent of planted acres*				
Nitrogen	87.8	n/a	95.8	96.0	80.9	72.3	86.1	87.0
Phosphate	58.2	n/a	92.5	81.8	52.6	57.6	56.7	62.7
Potash	9.8	n/a	22.7	43.7	8.6	13.3	36.3	17.7
Herbicides	63.1	n/a	95.3	67.4	74.4	83.6	45.1	69.7
Insecticides	8.8	n/a	1.7	0.8	1.2	id	id	3.7
Average application rates for:				*Pounds a.i. per treated acre*				
Nitrogen	62	n/a	73	79	59	57	74	64
Phosphate	30	n/a	29	44	27	36	49	33
Potash	21	n/a	12	50	25	45	60	38
Herbicides	0.29	n/a	0.67	0.47	0.44	0.49	0.10	0.41
Insecticides	0.36	n/a	0.50	0.30	0.38	id	id	0.36

Id = Insufficient data. n/a = Not applicable. [1] For States included, see "Cropping Practices Survey" in the appendix. [2] See box, "Cropping Pattern Definitions." Source: USDA, ERS, Cropping Practices Survey data.

and may reflect regional and weather variations. Continuous wheat showed the lowest percentage of wheat acres treated with herbicides, but this may be due to the agroclimatic conditions in the region where this pattern predominates.

Insecticide use. Insecticide use on continuous corn occurred much more frequently than on corn in rotations (table 4.3.1). Higher use of insecticides on continuous corn is needed to reduce the build up of insects, especially corn rootworm, which monoculture tends to encourage. Alternating crops with corn reduces the need for insecticide treatment because rootworms and other populations are not allowed to build up. Three-fourth of cotton acres were treated with insecticide, with little difference among patterns in average amount applied. Soybeans usually are not treated with insecticide. While only a small part of wheat acreage was treated with insecticides, the proportion of continuous wheat treated was higher than that for wheat in various rotations.

Fertilizer use. Most corn, cotton, and wheat acres received nitrogen fertilizer in 1995, with smaller proportions receiving phosphate and potash (table 4.3.1). Cropping patterns generally did not influence average annual pounds applied except nitrogen use was higher for continuous corn than for some rotations, and lower for continuous cotton than for some rotations.

Factors Affecting Cropping Patterns

The primary factor determining a farmer's choice of cropping pattern is the rate of return; other contributing factors include agroclimatic conditions, farm programs, conservation programs, and environmental regulations. Crop rotations, generally, will prevail over monoculture only if more profitable as in Iowa, where corn-soybeans-corn was shown to yield $40 per acre more than continuous corn (Duffy, 1996).

Climate, rainfall, environmental, and economic conditions divide the United States into very distinct agroclimatic regions, with each region's conditions determining its needs and ability to rotate crops. For example, the level and the variability of rainfall in a given area determine the usefulness of legumes in a rotation. Alfalfa and other deep-rooted legumes can deplete the subsoil moisture to a greater depth than corn. As a result, in arid and semi-arid regions and in subhumid and humid regions during drought, the inclusion of these legumes in a rotation may reduce the yields of the following corn or other crops. Under irrigated conditions or in areas of abundant rainfall, however, legumes in rotation with cash grains will boost yield and reduce the need for fertilizer by providing for some or all of the nitrogen needed by corn or small grains (National Research Council, 1989).

Federal policies often unintentionally discourage the adoption of crop rotations. For example, commodity programs that restricted base acreage to one or two crops encouraged monoculture. To reduce this unintended effect, the 1990 Farm Act eliminated deficiency payments on 15 percent of participating crop base acres known as Normal Flex Acreage (NFA), regardless of the crops planted on them (with a few fruit and vegetable exceptions). As a result, many farmers flexed out of monoculture or idled the marginal acreage. The extent of flexing out varied by type of crop base, depending on expected relative market return. For example, oats appeared to be the least profitable program crop during 1991-94 as almost half of its NFA was flexed to another crop. The 1996 Farm Act allows 100 percent flexing (again with a few fruit and vegetable exceptions).

Under the 1985 and subsequent farm acts, highly erodible land (HEL) used for crops requires a conservation plan to qualify for USDA farm program benefits (see chapter 6.4, *Conservation Compliance*, for more detail). Planting crops in rotation can reduce erosion and is a part of many conservation plans for HEL. Indeed, more HEL in corn in 1995 was in rotation (18 percent) than was non-HEL (12 percent) (table 4.3.2). Also more winter, spring, and durum wheat (50, 64, and 46 percent respectively) on HEL was in a fallow or idle rotation than non-HEL (34, 20, and 44 percent).

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Table 4.3.2—Cropping patterns on highly and non-highly erodible land in major producing States, 1995

Category	Corn (17 States	Soybeans (14 States)	Cotton (16 States)	Winter wheat (11 States)	Spring wheat (4 States)	Durum wheat (ND)	Total
Planted acres (1,000)[1]	64,105	51,840	11,650	34,265	15,750	2,950	180,560
Erodibility:				*Percent of planted acres*			
Highly erodible land (HEL)	18	15	20	34	26	24	21
Land not highly erodible	78	77	70	63	71	75	74
Land not designated	4	8	10	3	3	2	5
Three-year crop sequence on HEL:				*Percent of HEL planted acres*			
Continuous same crop	25	6	84	40	20	22	29
Continuous row crops	58	78	10	n/a	n/a	n/a	34
Continuous small grains	n/a	n/a	n/a	id	2	15	
Row crop and small grains[2]	3	9	1	10	14	15	8
Idle or fallow in rotation	11	7	4	50	64	46	28
Hay or other crops in rotation	4	id	id	id	id	id	1
Three-year crop sequence on non-HEL:				*Percent of non-HEL planted acres*			
Continuous same crop	22	10	67	45	15	23	24
Continuous row crops	67	74	24	n/a	n/a	n/a	53
Continuous small grains	n/a	n/a	n/a	id	12	12	1
Row crop and small grains[2]	3	11	2	20	52	20	10
Idle or fallow in rotation	7	4	7	34	20	44	12

n/a = not applicable. Id = insufficient data. Percentages may not add to 100 due to rounding.
[1] For the States included, see "Cropping Practices Survey" in the appendix. [2] Includes double-cropped with wheat or soybeans.
Source: USDA, ERS, Cropping Practices Survey data.

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